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(57) **ABSTRACT**

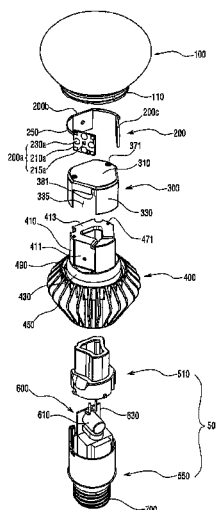
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**34 Claims, 9 Drawing Sheets**



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Fig. 1

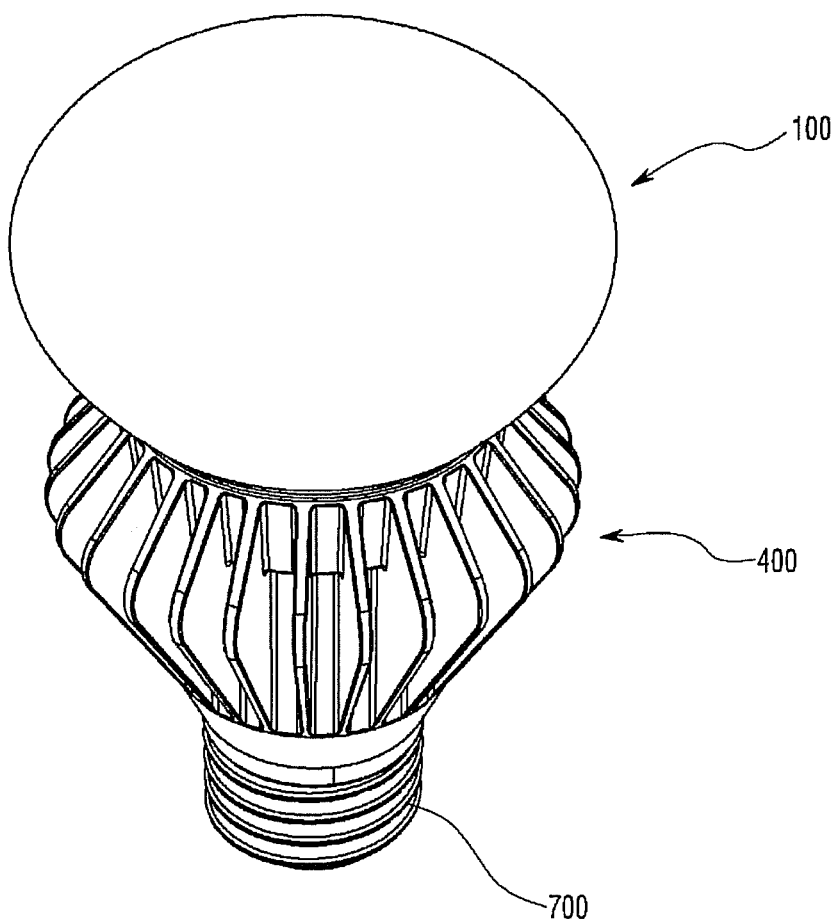


Fig. 2

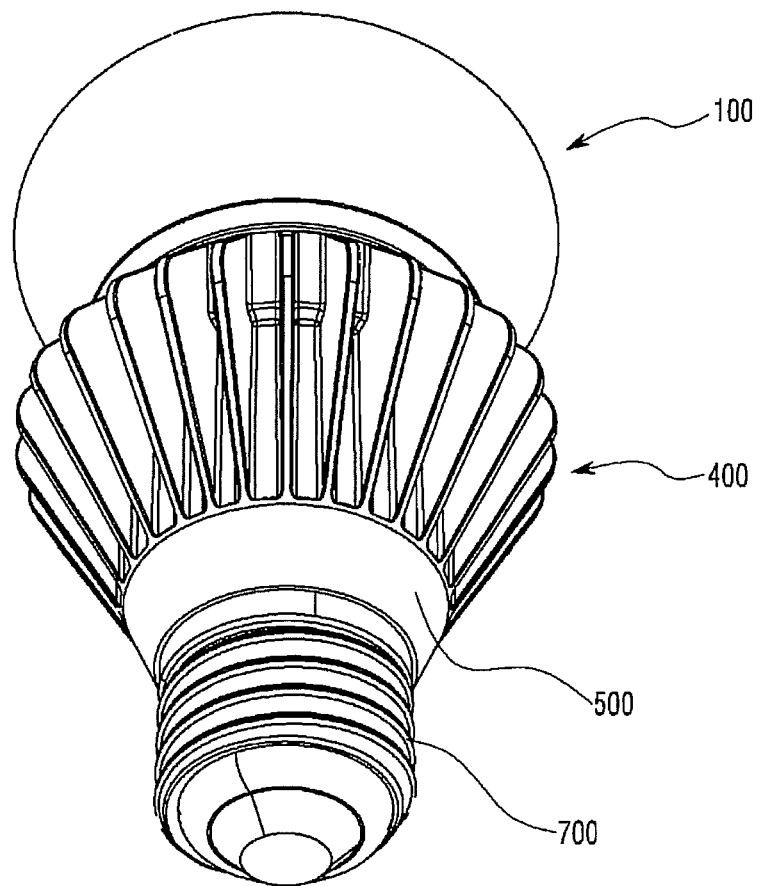


Fig. 3

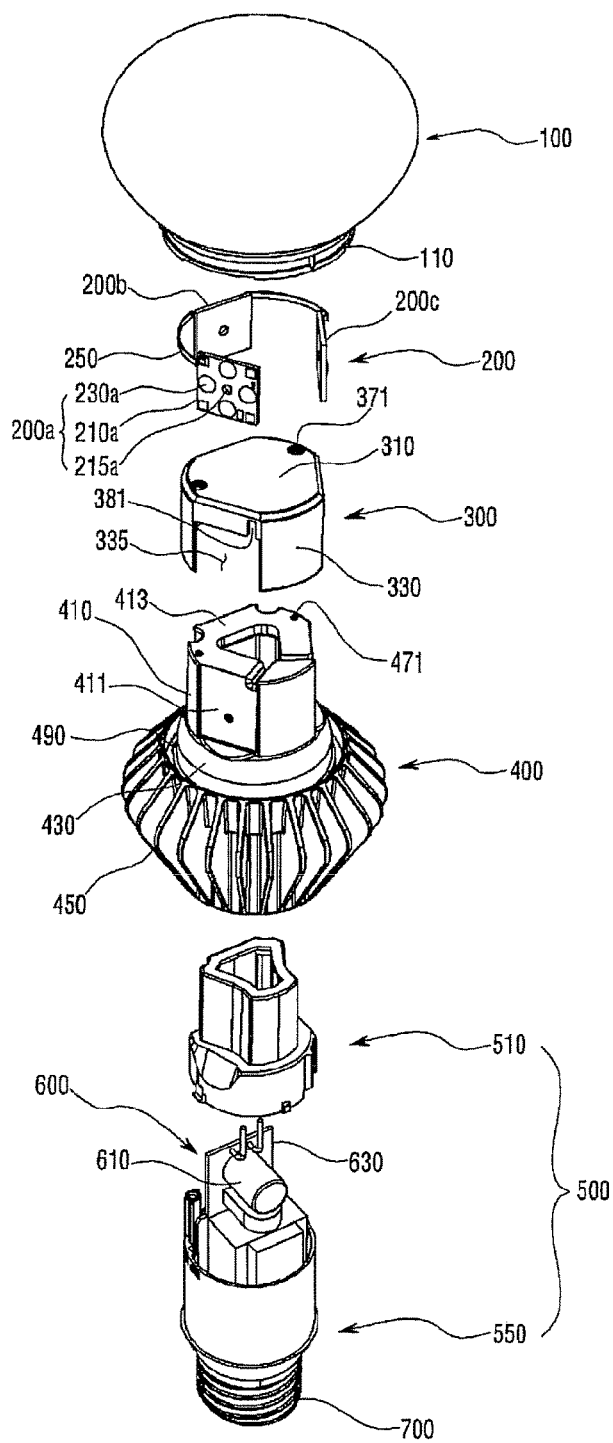


Fig. 4

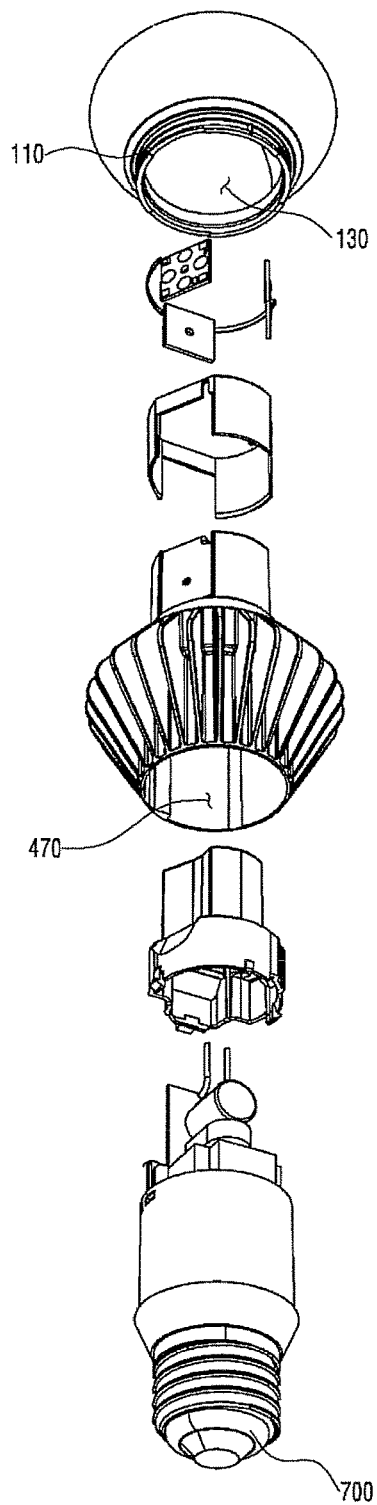


Fig. 5

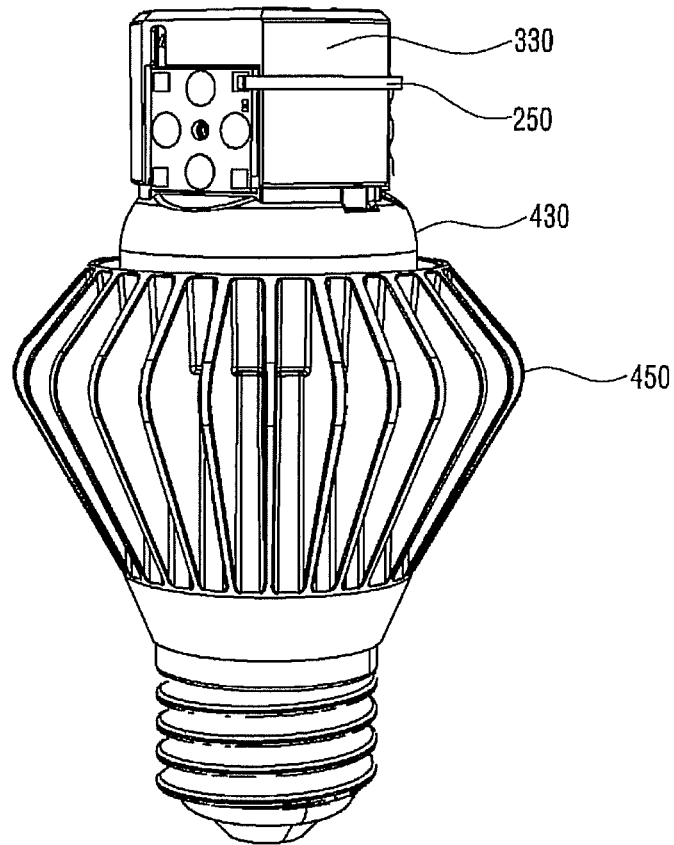




Fig. 6

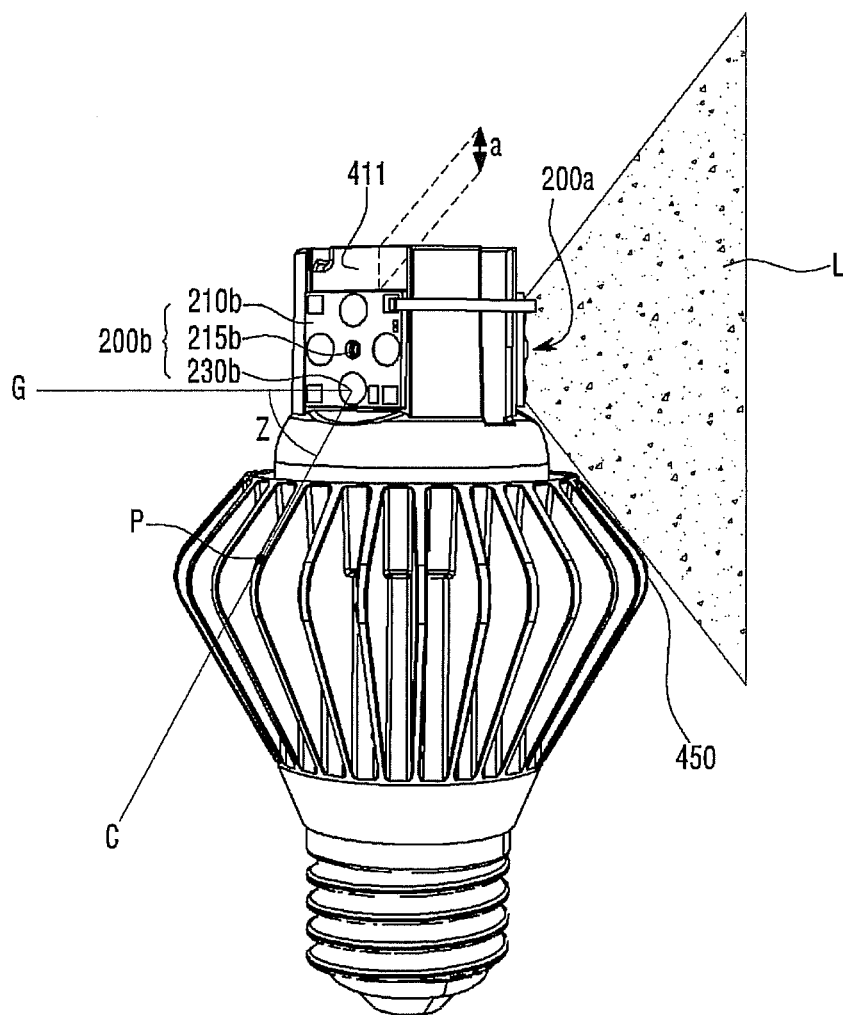


Fig. 7

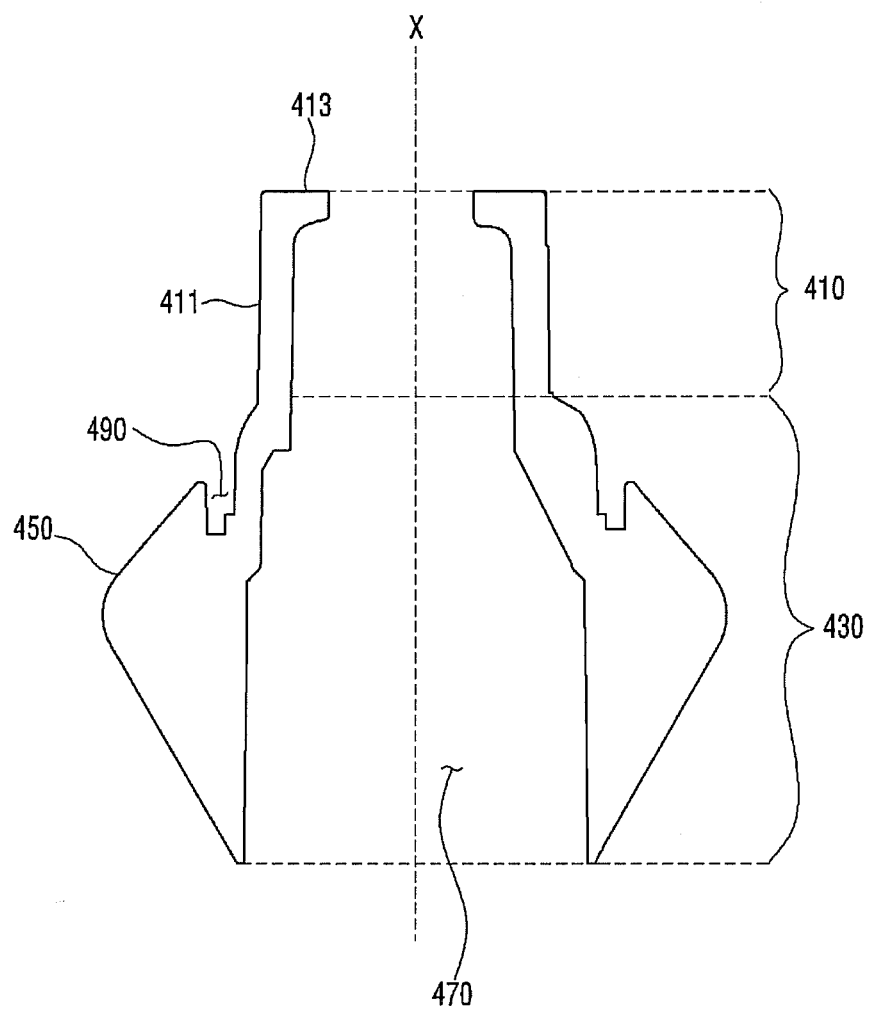


Fig. 8

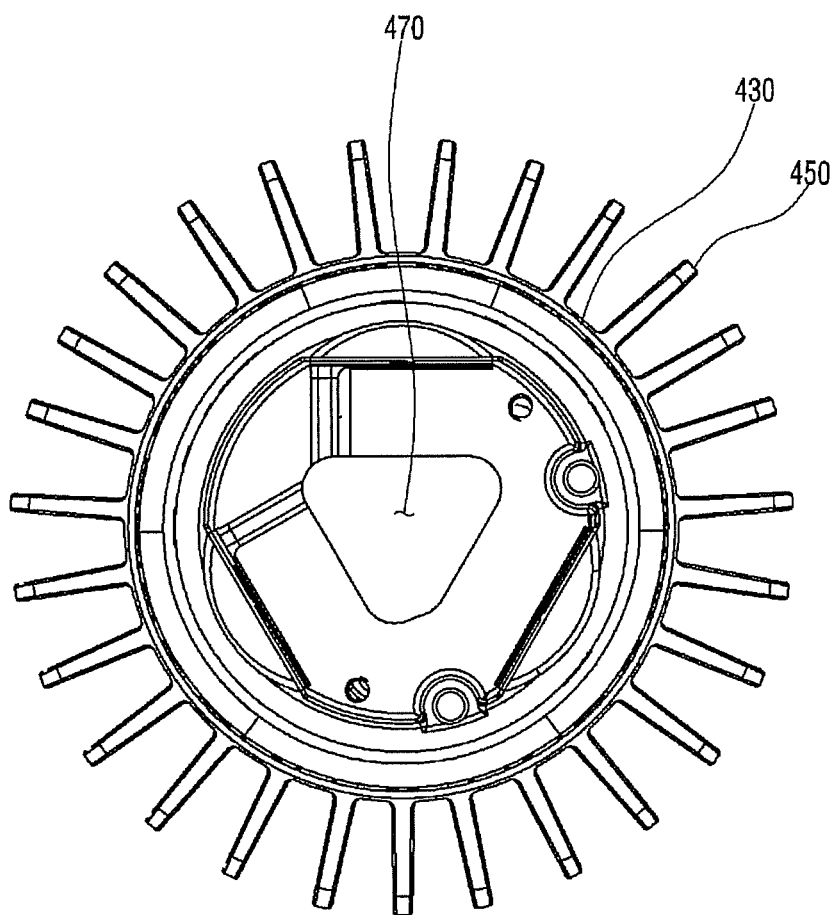
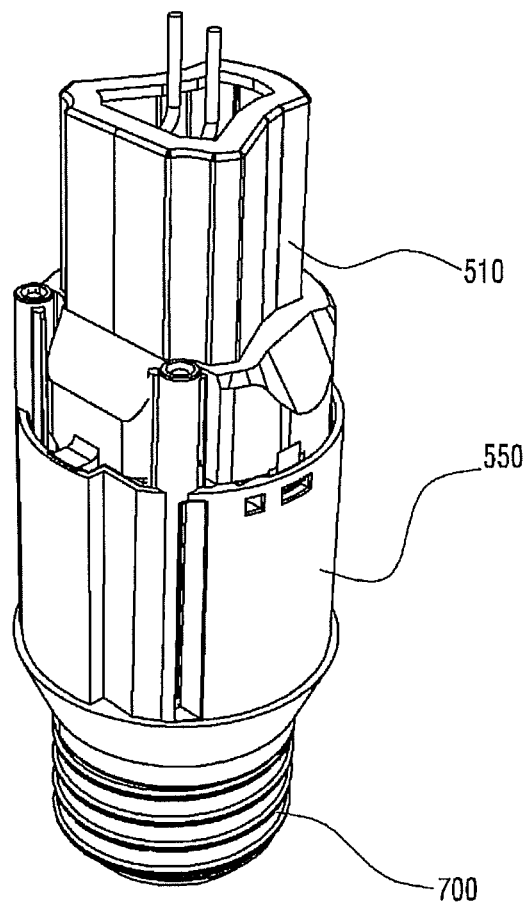


Fig. 9



# LIGHTING DEVICE HAVING REFLECTORS FOR INDIRECT LIGHT EMISSION

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.**

## CROSS-REFERENCE TO RELATED [APPLICA- TION] APPLICATIONS

[The present] *This application is a Reissue Application of prior U.S. Pat. No. 8,680,755 issued Mar. 25, 2014 (U.S. patent application Ser. No. 13/738,605 filed Jan. 10, 2013), which claims priority under 35 U.S.C. §119(e) of Korean Patent Application No. 10-2012-0048246 filed May 7, 2012, No. 10-2012-0055593 filed May 24, 2012, No. 10-2012-0055594 filed May 24, 2012, No. 10-2012-0055595 filed May 24, 2012, [the subject matters of which] whose entire disclosures are incorporated herein by reference.*

## BACKGROUND

### 1. Field

The inventions relates to a lighting device.

### 2. Background

A light emitting diode (LED) is an energy device for converting electric energy into light energy. Compared with an electric bulb, the LED has higher conversion efficiency, lower power consumption and a longer life span. As there advantages are widely known, more and more attentions are now paid to a lighting apparatus using the LED.

The lighting apparatus using the LED are generally classified into a direct lighting apparatus and an indirect lighting apparatus. The direct lighting apparatus emits light emitted from the LED without changing the path of the light. The indirect lighting apparatus emits light emitted from the LED by changing the path of the light through reflecting means and so on. Compared with the direct lighting apparatus, the indirect lighting apparatus mitigates to some degree the intensified light emitted from the LED and protects the eyes of users.

## SUMMARY

One embodiment is a lighting device. The lighting device includes: a heat sink which includes a base and a member extending from the base; a light source module which is disposed on a lateral surface of the member; and a reflector which is disposed on the member and has a disposition recess exposing the light source module. The at least two light source modules are provided and the light source module includes a terminal plate which electrically connects the at least two light source modules. The terminal plate is disposed on the reflector.

The reflector may have a shape corresponding to that of the member and wherein the reflector covers the member. The heat sink may comprise a receiver which passes through the base and the member. The reflector may comprise a lower portion having the disposition recess, and an upper portion disposed on the receiver.

The lighting device may further comprises a cover which is disposed on the reflector and is coupled to the heat sink. The upper portion of the reflector may have a surface convex

toward the cover. An angle between the lateral surface of the member and a central axis of the lighting device may be equal to or greater than 0.3 degree and equal to or less than 3 degree.

The lateral surface of the member of the heat sink may be curved. The light source module may comprise a flexible substrate disposed on the curved surface and a light emitting diode disposed on the substrate.

The heat radiating fin may comprise an upper portion and a lower portion. A width of the upper portion of the heat radiating fin may increase with the approach to a lower portion of the base from an upper portion of the base. A width of the lower portion of the heat radiating fin may decrease with the approach to the lower portion of the base from the upper portion of the base. The upper portion of the heat radiating fin may be disposed under a light distribution area of light emitted from the light source module and not overlapped with the light distribution area.

A thickness of the heat radiating fin may be equal to or larger than 0.8 mm and is equal to or less than 3.0 mm. On the basis of a vertical axis passing through a center of the light emitting device, a maximum emission angle of the light emitting device may be defined by an angle between the vertical axis and a tangent line passing through both the center of the light emitting device and a contact point of the upper portion of the heat radiating fin. A plurality of the heat radiating fins may be disposed to surround the outer surface of the base of the heat sink and may be separated from each other at a predetermined interval. An interval between the outermost ends of the two adjacent heat radiating fins among the plurality of the heat radiating fins may be different from an interval between the innermost ends of the two adjacent heat radiating fins.

The light source module may comprise a substrate disposed on the lateral surface of the member of the heat sink, and the light emitting device disposed on the substrate. An area of the lateral surface of the member may be greater than that of the bottom surface of the substrate. The substrate may be disposed to lean more on the lower portion of the lateral surface of the member than the upper portion of the lateral surface of the member, so that a portion of the lateral surface of the member is exposed.

A distance from the uppermost portion of the member to the uppermost portion of the substrate may be equal to or greater than 3 mm and is equal to or less than 5 mm. The heat sink may comprise a receiver passing through the base and the member. The member may further comprise an extension part extending toward the receiver.

A length of the extension part may be equal to or greater than 10 mm and be equal to or less than 20 mm on the basis of the lateral surface of the member. A thickness of the member may be equal to or larger than 2.5 mm and be equal to or less than 5 mm.

Another embodiment is a lighting device. The lighting device includes: a heat sink including a base including a heat radiating fin, and a member which extends from the base and has at least one lateral surface; and a light source module disposed on the lateral surface of the member of the heat sink and comprising a light emitting device. The heat radiating fin may include an upper portion and a lower portion. A width of the upper portion of the heat radiating fin may increase with the approach to a lower portion of the base from an upper portion of the base. A width of the lower portion of the heat radiating fin may decrease with the approach to the lower portion of the base from the upper portion of the base. The upper portion of the heat radiating fin may be disposed under a light distribution area of light

emitted from the light source module and not overlapped with the light distribution area.

The reflector may have a shape corresponding to that of the member and wherein the reflector covers the member. The heat sink may comprise a receiver which passes through the base and the member. The reflector may comprise a lower portion having the disposition recess, and an upper portion disposed on the receiver.

The lighting device may further comprises a cover which is disposed on the reflector and is coupled to the heat sink. The upper portion of the reflector may have a surface convex toward the cover. An angle between the lateral surface of the member and a central axis of the lighting device may be equal to or greater than 0.3 degree and equal to or less than 3 degree.

The lateral surface of the member of the heat sink may be curved. The light source module may comprise a flexible substrate disposed on the curved surface and a light emitting diode disposed on the substrate.

The heat radiating fin may comprise an upper portion and a lower portion. A width of the upper portion of the heat radiating fin may increase with the approach to a lower portion of the base from an upper portion of the base. A width of the lower portion of the heat radiating fin may decrease with the approach to the lower portion of the base from the upper portion of the base. The upper portion of the heat radiating fin may be disposed under a light distribution area of light emitted from the light source module and not overlapped with the light distribution area.

A thickness of the heat radiating fin may be equal to or larger than 0.8 mm and is equal to or less than 3.0 mm. On the basis of a vertical axis passing through a center of the light emitting device, a maximum emission angle of the light emitting device may be defined by an angle between the vertical axis and a tangent line passing through both the center of the light emitting device and a contact point of the upper portion of the heat radiating fin. A plurality of the heat radiating fins may be disposed to surround the outer surface of the base of the heat sink and may be separated from each other at a predetermined interval. An interval between the outermost ends of the two adjacent heat radiating fins among the plurality of the heat radiating fins may be different from an interval between the innermost ends of the two adjacent heat radiating fins.

The light source module may comprise a substrate disposed on the lateral surface of the member of the heat sink, and the light emitting device disposed on the substrate. An area of the lateral surface of the member may be greater than that of the bottom surface of the substrate. The substrate may be disposed to lean more on the lower portion of the lateral surface of the member than the upper portion of the lateral surface of the member, so that a portion of the lateral surface of the member is exposed.

A distance from the uppermost portion of the member to the uppermost portion of the substrate may be equal to or greater than 3 mm and is equal to or less than 5 mm. The heat sink may comprise a receiver passing through the base and the member. The member may further comprise an extension part extending toward the receiver.

A length of the extension part may be equal to or greater than 10 mm and be equal to or less than 20 mm on the basis of the lateral surface of the member. A thickness of the member may be equal to or larger than 2.5 mm and be equal to or less than 5 mm.

Further another embodiment is a lighting device. The lighting device includes: a heat sink including a base and a member disposed on the base; a light source module dis-

posed on the member of the heat sink; a housing which is disposed in the base of the heat sink and inside the member of the heat sink and is formed of a material having electrical insulation; and a power supply which is received inside the housing and supplies electrical power to the light source module. The housing includes an upper housing and a lower housing. The upper housing is surrounded by the member of the heat sink. The lower housing is surrounded by the base of the heat sink. The upper housing receives an upper portion of the power supply, and wherein the lower housing receives the rest portion of the power supply.

The heat sink may comprise a receiver which passes through the base and the member, the receiver of the heat sink may be a through-hole. The through-hole may have a shape corresponding to that of the housing.

The through-hole may comprise an upper portion defined by the member of the heat sink, and a lower portion defined by the base of the heat sink. A space volume of the upper portion of the through-hole may be different from that of the lower portion of the through-hole. The lower housing may comprise a molding part for fixing the power supply.

The reflector may have a shape corresponding to that of the member and wherein the reflector covers the member. The heat sink may comprise a receiver which passes through the base and the member. The reflector may comprise a lower portion having the disposition recess, and an upper portion disposed on the receiver.

The lighting device may further comprise a cover which is disposed on the reflector and is coupled to the heat sink. The upper portion of the reflector may have a surface convex toward the cover. An angle between the lateral surface of the member and a central axis of the lighting device may be equal to or greater than 0.3 degree and equal to or less than 3 degree.

The lateral surface of the member of the heat sink may be curved. The light source module may comprise a flexible substrate disposed on the curved surface and a light emitting diode disposed on the substrate.

The heat radiating fin may comprise an upper portion and a lower portion. A width of the upper portion of the heat radiating fin may increase with the approach to a lower portion of the base from an upper portion of the base. A width of the lower portion of the heat radiating fin may decrease with the approach to the lower portion of the base from the upper portion of the base. The upper portion of the heat radiating fin may be disposed under a light distribution area of light emitted from the light source module and not overlapped with the light distribution area.

A thickness of the heat radiating fin may be equal to or larger than 0.8 mm and is equal to or less than 3.0 mm. On the basis of a vertical axis passing through a center of the light emitting device, a maximum emission angle of the light emitting device may be defined by an angle between the vertical axis and a tangent line passing through both the center of the light emitting device and a contact point of the upper portion of the heat radiating fin. A plurality of the heat radiating fins may be disposed to surround the outer surface of the base of the heat sink and may be separated from each other at a predetermined interval. An interval between the outermost ends of the two adjacent heat radiating fins among the plurality of the heat radiating fins may be different from an interval between the innermost ends of the two adjacent heat radiating fins.

The light source module may comprise a substrate disposed on the lateral surface of the member of the heat sink, and the light emitting device disposed on the substrate. An area of the lateral surface of the member may be greater than

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that of the bottom surface of the substrate. The substrate may be disposed to lean more on the lower portion of the lateral surface of the member than the upper portion of the lateral surface of the member, so that a portion of the lateral surface of the member is exposed.

A distance from the uppermost portion of the member to the uppermost portion of the substrate may be equal to or greater than 3 mm and is equal to or less than 5 mm. The heat sink may comprise a receiver passing through the base and the member. The member may further comprise an extension part extending toward the receiver.

A length of the extension part may be equal to or greater than 10 mm and be equal to or less than 20 mm on the basis of the lateral surface of the member. A thickness of the member may be equal to or larger than 2.5 mm and be equal to or less than 5 mm.

A portion of the cover and a portion of the heat sink may have a shape suitable to couple the cover to the heat sink.

The lighting device according to the invention is capable of performing optimum omni-directional light distribution.

The lighting device according to the invention is capable of enhancing heat radiation performance.

The lighting device according to the invention is capable of blocking electrical contact between a light source module and a heat sink.

The lighting device according to the invention is capable of removing a dark portion which may be generated in a cover.

The lighting device according to the invention has good workability in assemblage or manufacture.

The lighting device according to the invention is capable of improving light-extraction efficiency.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Arrangements and embodiments may be described in detail with reference to the following drawings in which like reference numerals refer to like elements and wherein:

FIG. 1 is a top perspective view of a lighting device according to an embodiment;

FIG. 2 is a bottom perspective view of the lighting device shown in FIG. 1;

FIG. 3 is an exploded perspective view of the lighting device shown in FIG. 1;

FIG. 4 is an exploded perspective view of the lighting device shown in FIG. 2;

FIG. 5 is a front view showing that the lighting device shown in FIG. 1 does not include a cover;

FIG. 6 is a front view showing that the lighting device shown in FIG. 1 does not include a cover and a reflector;

FIG. 7 is a cross sectional view of a heat sink alone shown in FIG. 2;

FIG. 8 is a plan view of the heat sink shown in FIG. 2; and

FIG. 9 is a perspective view of a housing alone shown in FIG. 2.

#### DETAILED DESCRIPTION

The invention will be now disclosed making reference to the enclosed drawings and disclosing more than one embodiment. A skilled in this art will easily understand that the invention is not limited to a single embodiment but that some features and functional characteristics may be in common to the various embodiments so that some of the inventive features of different embodiments may even be merged and combined even if not explicitly reported in the corresponding description.

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A thickness or a size of each layer may be magnified, omitted or schematically shown for the purpose of convenience and clearness of description. The size of each component may not necessarily mean its actual size.

It should be understood that when an element is referred to as being 'on' or "under" another element, it may be directly on/under the element, and/or one or more intervening elements may also be present. When an element is referred to as being 'on' or 'under', 'under the element' as well as 'on the element' may be included based on the element.

An embodiment may be described in detail with reference to the accompanying drawings.

FIG. 1 is a top perspective view of a lighting device according to an embodiment. FIG. 2 is a bottom perspective view of the lighting device shown in FIG. 1. FIG. 3 is an exploded perspective view of the lighting device shown in FIG. 1. FIG. 4 is an exploded perspective view of the lighting device shown in FIG. 2. FIG. 5 is a front view showing that the lighting device shown in FIG. 1 does not include a cover. FIG. 6 is a front view showing that the lighting device shown in FIG. 1 does not include a cover and a reflector.

Referring to FIGS. 1 to 6, the lighting device according to the embodiment may include a cover 100, a light source module 200, a reflector 300, a heat sink 400, a housing 500, a power supply 600 and a socket 700. Hereafter, the components will be described in detail respectively.

#### <Cover 100>

The cover 100 has a bulb shape with an empty interior. The cover 100 also has a partial opening 130 of which a portion has been opened.

The cover 100 is optically connected to the light source module 200. For example, the cover 100 may diffuse, scatter or excite light emitted from the light source module 200.

The cover 100 is coupled to the heat sink 400. For this, a portion of the cover 100 and a portion of the heat sink 400 may have a shape suitable to couple the cover 100 to the heat sink 400. For example, the cover 100 may include a coupler 110. The coupler 110 may be inserted into a coupling recess 490 of the heat sink 400. The coupler 110 may have a screw thread-shaped coupling structure. A screw recess-shaped structure corresponding to the screw thread-shaped coupling structure is formed in the coupling recess 490, thereby making it easier for the cover 100 and the heat sink 400 to be coupled to each other. Therefore, workability can be enhanced.

The thickness of the cover 100 may have a value within a range between 1 mm and 2 mm.

The cover 100 may be made of a light diffusing polycarbonate (PC) for the purpose of prevent a user from feeling glare caused by the light emitted from the light source module 200. Further, the cover 100 may be made of any one of glass, plastic, polypropylene (PP) and polyethylene (PE).

The inner surface of the cover 100 may be anti-corrosion treated. Moreover, a predetermined pattern may be applied to the outer surface of the cover 100. With this feature the light emitted from the light source module 200 can be scattered. Accordingly, the user is able to avoid the glare.

The cover 100 may be manufactured by a blow molding process for the sake of uniform light distribution of omni-directional light. In the blow molding process, the diameter of the opening 130 of the cover 100 may be from 3 mm to 20 mm.

Embossing pattern may be formed on the surface of the cover 100. Preferably, the embossing pattern may be formed

on the surface of the cover **100** close to the partial opening **130**. This structure can improve the scatter of light.

In a modified embodiment, the cover **100** may include a plurality of protrusions (un-drawn). The heat sink **400** may have a plurality of recesses whose position corresponding to those of the plurality of protrusions of the cover **100**. The plurality of protrusions may be shaped suitable to be inserted and locked into the plurality of recesses of the heat sink **400**. For example, the tips of the protrusions may be trapezoidal so that the protrusions can be locked in the recesses of the heat sink **400**. Due to the structure, workability can be enhanced.

#### <Light Source Module **200**>

The light source module **200** emits a predetermined light.

A plurality of the light source modules **200** may be provided. Specifically, the light source module **200** may include a first light source module **200a**, a second light source module **200b** and a third light source module **200c**.

The first to the third light source modules **200a**, **200b** and **200c** may respectively include a substrate **210a** and a light emitting device **230a** disposed on the substrate **210a**.

The substrate **210a** may be formed by printing a circuit pattern on an insulator. For example, the substrate **210a** may include a general printed circuit board (PCB), a metal core PCB, a flexible PCB, a ceramic PCB and the like. The surface of the substrate **210a** may be formed of a material capable of efficiently reflecting light. The surface of the substrate **210a** may be coated with a color capable of efficiently reflecting light, for example, white, silver and the like.

A predetermined hole **215a** may be formed in the center of the substrate **210a**. The hole **215a** may be a reference point for arranging the light emitting devices **230a**. A screw may be inserted into the hole **215a** in order to fix the substrate **210a** to the heat sink **400**. The screw can serve as a thermal path, so the heat transfer from the substrate **210a** to the heat sink **400** can improve.

At least one light emitting device **230a** may be disposed on one side of the substrate **210a**. In FIG. 3, a plurality of the light emitting devices **230a** may be disposed on one side of the substrate **210a**. The light emitting device **230a** may be a light emitting diode chip emitting red, green and blue light or a light emitting diode chip emitting ultraviolet light. Here, the light emitting diode chip may have a lateral type or a vertical type and may emit blue, red, yellow or green light.

A lens may be disposed on the light emitting device **230a**. The lens is disposed to cover the light emitting device **230a**. The lens is able to adjust an emission angle or a direction of light emitted from the light emitting device **230a**. The lens may be a hemispherical shape and may be made of a light transmitting resin like silicone resin or epoxy resin without an empty space. The light transmitting resin may wholly or partially include a distributed fluorescent material.

When the light emitting device **230a** is a blue light emitting diode, the fluorescent material included in the light transmitting resin may include at least one selected from a group consisting of a garnet material (YAG, TAG), a silicate material, a nitride material and an oxynitride material.

Though natural light (white light) can be created by allowing the light transmitting resin to include only yellow fluorescent material, the light transmitting resin may further include a green fluorescent material or a red fluorescent material in order to improve a color rendering index and to reduce a color temperature.

When the light transmitting resin is mixed with many kinds of fluorescent materials, an addition ratio of the color of the fluorescent material may be formed such that the

green fluorescent material is more used than the red fluorescent material, and the yellow fluorescent material is more used than the green fluorescent material. The garnet material, the silicate material and the oxynitride material may be used as the yellow fluorescent material. The silicate material and the oxynitride material may be used as the green fluorescent material. The nitride material may be used as the red fluorescent material. The light transmitting resin may be mixed with various kinds of the fluorescent materials or may be configured by a layer including the red fluorescent material, a layer including the green fluorescent material and a layer including the yellow fluorescent material, which are formed separately from each other.

The light source module **200** may include a terminal plate **250**. The first to the third light source modules **200a**, **200b** and **200c** may be electrically connected to each other by means of the terminal plate **250**. For example, the first to the third light source modules **200a**, **200b** and **200c** may be electrically connected in series to each other through use of the two terminal plates **250**.

The terminal plate **250** may be made of a conductive metallic material. For instance, the terminal plate **250** may be made by using any one of copper, nickel and zinc plating or the compound comprising at least two selected from copper, nickel and zinc plating. For the purpose of manufacturing the light source module **200**, the terminal plate **250** may be made of a metallic material which is easily bent. By using the terminal plate **250**, the workability for installing the light source module **200** in the heat sink **400** can be improved and the light source modules are more stably connected to each other than they are connected by using a wire.

Preferably, the thickness of the terminal plate **250** may be from 0.1 mm to 0.5 mm. If the thickness is less than 0.1 mm, the terminal plate **250** would be easily snapped in the manufacturing process or by an external shock. If the thickness is more than 0.5 mm, the terminal plate **250** can be difficult to bend.

The light source module **200** is disposed in the heat sink **400**. Specifically, the substrates **210a** of the first to the third light source modules **200a**, **200b** and **200c** may be disposed on an outer lateral surface **411** of a member **410** of the heat sink **400**. The laterally arranged light source modules **200a**, **200b**, and **200c** can improve the performance of omnidirectional light by scattering the light uniformly throughout the cover **100**.

#### <Reflector **300**>

The reflector **300** is coupled to the heat sink **400**. Specifically, the reflector **300** may be coupled to the member **410** of the heat sink **400**.

The reflector **300** has a shape corresponding to that of the member **410** of the heat sink **400**. Also, the reflector **300** may have a shape covering the member **410** of the heat sink **400**. Specifically, the reflector **300** may include an upper portion **310** and a lower portion **330**. The upper portion **310** is disposed on the top surface of the member **410** of the heat sink **400**. The lower portion **330** is disposed on the lateral surface of the member **410** of the heat sink **400**. In other words, the lower portion **330** may extend from the periphery of the upper portion **310** along the lateral surface of the member **410**. The upper portion **310** may be substantially perpendicular to the lower portion **330**.

The upper portion **310** of the reflector **300** may include a flat surface or a surface convex toward the cover **100**. When the upper portion **310** of the reflector **300** includes the



convex surface, there is an advantage of reducing dark portions which may be generated in the uppermost portion of the cover 100.

The reflector 300 may have a coupling means suitable to be coupled to the heat sink 400, and the heat sink 400 may have a corresponding coupling means. For example, the upper portion 310 of the reflector 300 may have at least one hole 371, and the top surface of the member 410 of the heat sink 400 may have at least one hole 471 at the corresponding position of the holes of the upper portion 310 of the reflector 300. Both holes can be fastened by a fastening means, such as a screw. But, the coupling means of the reflector 300 and the heat sink 400 is not limited thereto.

The minimum distance from the upper portion 310 of the reflector 300 to the uppermost portion of the cover 100 may be equal to or greater than 15 mm. If the distance from the upper portion 310 of the reflector 300 to the inner surface of the cover 100 is less than and not equal to 15 mm, the dark portion may be generated in the uppermost portion of the cover 100. When the minimum distance from the upper portion 310 of the reflector 300 to the inner surface of the cover 100 is equal to or greater than 15 mm, the dark portion can be remarkably reduced and density of the dark portion can be more reduced.

The reflector 300 may have a disposition recess 335. The disposition recess 335 may be formed in the lower portion 330 of the reflector 300. The light source module 200 disposed in the member 410 of the heat sink 400 may be disposed in the disposition recess 335. Specifically, the substrate 210a of the light source module 200 may be disposed in the disposition recess 335. While the reflector 300 is disposed on the member 410 of the heat sink 400, the disposition recess 335 prevents the reflector 300 from being disposed on the light source module 200.

The reflector 300 may be made of white polycarbonate (PC) which easily reflects the light emitted from the light source module 200 and has thermal resistance. The reflector 300 is able to raise light-extraction efficiency of the lighting device according to the embodiment.

The reflector 300 may be made of a material having electrical insulation. The reflector 300 may be disposed between the member 410 of the heat sink 400 and the terminal plate 250 of the light source module 200. Such a reflector 400 is able to block electrical contact between the terminal plate 250 and the heat sink 400.

A surface treatment process is performed on the surface of the reflector 300, so that the light from the light source module 200 is scattered and a user is able to avoid the glare.

The side surfaces of the substrates 210a of the light source module 200a may be arranged in parallel to the inner side of the disposition recess 335. At least one side surfaces of the substrates 210a may contact with the inner side of the disposition recess 335 when they are assembled.

The lower portion 330 of the reflector 300 may have a guide 381 through which the light source modules 200 are provided electric power from the power supply 600. The guide 381 may be a recess extended from the disposition recess 335 of the reflector 300. Alternatively, the guide 381 may be a hole formed on the surface between the disposition recess 335 and the upper portion 310 of the reflector 300.

<Heat Sink 400>

The light source module 200 is disposed on the heat sink 400. The heat sink 400 receives heat from the light source module 200 and radiates the heat. The heat sink 400 is coupled to the cover 100 and receives the power supply 600 and the housing 500.

FIG. 7 is a cross sectional view of the heat sink alone shown in FIG. 2.

Referring to FIGS. 1 to 7, the heat sink 400 may include the member 410, a base 430 and a heat radiating fin 450.

The member 410 may extend upward from the upper portion of the base 430. The member 410 may be integrally formed with the base 430 or may be formed separately from the base 430 and bonded or coupled to the base 430.

The member 410 may have a cylindrical shape. The light source module 200 is disposed on the outer surface of the cylindrical member 410.

The member 410 has the lateral surface 411 on which the light source module 200 is disposed. The member 410 has the lateral surface 411 of which the number is the same as the number of the light source modules 200. For example, the member 410 may have three lateral surfaces 411 on which the first to the third light source modules 200a, 200b and 200c are disposed respectively. The three lateral surfaces 411 may come in surface contact with the bottom surfaces of the substrates 210a of the first to the third light source modules 200a, 200b and 200c. For this purpose, the three lateral surfaces 411 may be flat. However, there is no limit to this. The three lateral surfaces 411 may be curved. In this case, the substrates 210a may be flexible substrates.

The lateral surface 411 may be, as shown in FIG. 7, substantially parallel with a central axis "X" of the lighting device according to the embodiment. Here, an angle between the lateral surface 411 and the central axis "X" may be from 0.3 degree to 3 degree. If the angle between the lateral surface 411 and the central axis "X" is from 0 degree to 0.3 degree, front light distribution characteristic is deteriorated. That is to say, a dark spot may be generated at the topmost portion of the cover 100. If the angle between the lateral surface 411 and the central axis "X" is greater than 3 degree, omni-directional distribution characteristic is deteriorated.

The area of the lateral surface 411 is, as shown in FIG. 6, greater than that of the bottom surface of the substrate 210a and is disposed to lean on the lower portion of the lateral surface 411 instead of the central portion of the lateral surface 411. Therefore, the substrate 210a is not disposed on the upper portion of the lateral surface 411. When the lateral surface 411 includes a portion on which the substrate 210a is not disposed, heat generated from the light source module 200 is transferred from the member 410 not only to the base 430 but also the upper portion of the member 410. Accordingly, the temperature of the light source module 200 can be rapidly reduced. As a result, it is possible to improve heat radiation performance of the lighting device according to the embodiment.

Here, a distance "a" from the uppermost portion of the lateral surface 411 to the uppermost portion of the substrate 210a may be from 3 mm to 5 mm. If the distance "a" is less than 3 mm, remarkable heat radiation effect is not obtained. If the distance "a" is greater than 5 mm, the dark portion generated in the uppermost portion of the cover 100 becomes thicker.

The thickness of the member 410 may be from 2.5 mm to 5 mm. If the thickness of the member 410 is less than 2.5 mm, heat radiation performance is degraded. If the thickness of the member 410 is greater than 5 mm, the material cost of the heat sink 400 is increased and an interior space for receiving the power supply 600 is reduced.

The member 410 may include an extension part 413. The extension part 413 may extend from the uppermost portion of the member 410 toward a receiver 470. Since the heat generated from the light source module 200 may be trans-

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ferred more to the upper portion of the member **410** by the extension part **413** and the heat transferred to the extension part **413** can cause heat convection in the receiver **470**, the temperature of the light source module **200** can be rapidly reduced. Therefore, it is possible to improve heat radiation performance of the lighting device according to the embodiment. Here, the length of the extension part **413** may be from 10 mm to 20 mm on the basis of the lateral surface **411**. The extension part **413** having a length less than 10 mm has no great influence on heat radiation performance improvement. The extension part **413** having a length greater than 20 mm does not allow the power supply **600** and the light source module **200** to be easily connected to each other.

In a modified embodiment, the extension part **413** may be formed separately from the uppermost portion of the member **410** and bonded or coupled to the uppermost portion of the member **410**.

The base **430** is disposed under the member **410**. The base **430** and the member **410** may be integrally formed with each other.

A plurality of the heat radiating fins **450** may be disposed on the outer surface of the base **430**. The plurality of the heat radiating fins **450** may project outward from the outer surface of the base **430**. The base **430** and the plurality of the heat radiating fins **450** may be integrally formed with each other or may be formed separately from each other and coupled to each other.

The heat radiating fin **450** may have an upper portion and a lower portion. The width of the upper portion of the heat radiating fin **450** increases with the approach to the lower portion of the base **430** from the upper portion of the base **430**. The width of the upper portion can be defined, for example, as the distance from a point of the heat radiating fin **450** located near the receiver **470** to a point on the outer periphery of the heat radiating fin **450** where the hypothetical line connecting the two points is substantially perpendicular to the outer surface of the base **430**. When the width of the upper portion of the heat radiating fin **450** increases with the approach to the lower portion of the base **430** from the upper portion of the base **430**, the omni-directional distribution characteristic of the lighting device according to the embodiment can be enhanced. This is because the light emitted from the light source module **200** is not blocked by the upper portion of the heat radiating fin **450**. This will be described in more detail with reference to FIG. **6**. To describe the structure in a different way, each of the heat radiating fin **450** has a triangular shape where first vertex of the triangle is located near one portion of the body close to the member **410**, second vertex of the triangle is located near the opposite portion of the body close to the housing **500**, and the third vertex of the triangle protrudes outward from the receiver **470**.

Referring to FIG. **6**, the upper portion of the heat radiating fin **450** may be formed in consideration of the light emitted from the light source module **200a**. Specifically, the upper portion of the heat radiating fin **450** may be formed in consideration of a light distribution area "L" of the light emitted from the light source module **200a**. In other words, the upper portion of the heat radiating fin **450** may be disposed under the light distribution area "L" of the light source module **200a**, or the upper portion of the heat radiating fin **450** may be disposed in such a manner as not to be overlapped with the light distribution area "L" of the light source module **200a**.

The emission angle of the light source module **200b** and the upper portion of the heat sink **400** may have the following relation. On the basis of a vertical axis "G"

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passing through the center of a light emitting device **230b**, the maximum emission angle "Z" of the light emitting device **230b** may be defined by an angle between the vertical axis "G" and a tangent line "C" passing through both the center of the light emitting device **230b** and a contact point of the upper portion of the heat radiating fin **450**. When the maximum emission angle "Z" of the light emitting device **230b** is defined in this manner, the omni-directional light distribution characteristic of the lighting device according to the embodiment can be enhanced. Here, the maximum emission angle "Z" may be from 50 degree to 80 degree. If the maximum emission angle "Z" is less than 50 degree, omni-directional light distribution meeting a standard specification cannot be obtained. If the maximum emission angle "Z" is greater than 80 degree, it is not possible to obtain a sufficient area for radiating the heat.

In the definition of the maximum emission angle "Z" of the light emitting device **230b**, the vertical axis "G" may pass through the center of a substrate **210b** instead of the center of the light emitting device **230b**. In other words, the vertical axis "G" may pass through a hole **215b** of the substrate **210b**.

FIG. **8** is a plan view of the heat sink **400** shown in FIG. **2**.

Referring to FIG. **8**, the heat radiating fin **450** may project perpendicularly to the outer surface of the base **430**.

The heat radiating fin **450** may become thinner from the outer surface of the base **430** to the outside. The thickness of the heat radiating fin **450** may be from 0.8 mm to 3.0 mm. If the thickness of the heat radiating fin **450** is less than 0.8 mm, the heat radiating fin **450** is difficult to be formed and an expected heat radiation effect cannot be obtained. If the thickness of the heat radiating fin **450** is larger than 3.0 mm, an interval between two adjacent heat radiating fins is reduced, so that when the heat sink **400** is powder-coated, a desired coating process cannot be performed between the two adjacent heat radiating fins.

The plurality of the heat radiating fins **450** may be separated from each other at a predetermined interval. Here, an interval between the outermost ends of the two heat radiating fins **450** may be from 6 mm to 7 mm, and an interval between the innermost ends of the two heat radiating fins **450** may be from 4 mm to 6 mm. When the interval between the outermost ends of the heat radiating fins **450** is different from the interval between the innermost ends of the heat radiating fins **450**, heat radiation performance can be improved and a powder coating process can be performed with ease to the innermost end of the heat radiating fin **450**.

The heat sink **400** has a receiver **470** for receiving the housing **500** therein. The receiver **470** may be a through-hole passing through the member **410** and the base **430** of the heat sink **400**. The through-hole **470** may be defined by a portion surrounded by the member **410** and a portion surrounded by the base **430**. The upper portion of the through-hole **470** is surrounded by the member **410**. The lower portion of the through-hole **470** is surrounded by the base **430**. The shape of the upper portion of the through-hole **470** is different from the shape of the lower portion of the through-hole **470**. Specifically, the upper portion of the through-hole **470** may have a volume less than that of the lower portion of the through-hole **470**. When the volume of the upper portion of the through-hole **470** is less than that of the lower portion of the through-hole **470**, even after the housing **500** is received in the through-hole **470** of the heat sink **400**, the housing **500** cannot fall into the upper portion of the through-hole **470**, which is surrounded by the member

410. Moreover, there is an advantage of improving the assemblability of the lighting device according to the embodiment.

The heat sink 400 may be formed of a metallic material or a resin material which has excellent heat radiation efficiency. The heat sink 400 may be formed of a material having high thermal conductivity (generally, greater than  $150 \text{ Wm}^{-1}\text{K}^{-1}$ , and more preferably, greater than  $200 \text{ Wm}^{-1}\text{K}^{-1}$ ), for example, copper (thermal conductivity of about  $400 \text{ Wm}^{-1}\text{K}^{-1}$ ), aluminum (thermal conductivity of about  $250 \text{ Wm}^{-1}\text{K}^{-1}$ ), anodized aluminum, aluminum alloy and magnesium alloy. Also, the heat sink 400 may be formed of a metal loaded plastic material like polymer, for example, epoxy or thermally conductive ceramic material (e.g., aluminum silicon carbide (AlSiC) (thermal conductivity of about  $170$  to  $200 \text{ Wm}^{-1}\text{K}^{-1}$ ).

In a modified embodiment, at least one heat radiating fin 450 may have a different measure from other heat radiating fin 450. Particularly, the heat radiating fin 450 having different measure may have an additional area protruding toward the cover 100. The additional area is shaped such that the cover 100 can be coupled to the heat sink 400. Preferably, the number of the at least one heat radiating fin 450 may be three, and the three heat radiating fin 450 may be uniformly arranged on the circumference of the heat sink 400. In other words, the distance between each of the three heat radiating fin 450 may be approximately identical.

<Housing 500>

FIG. 9 is a perspective view of the housing alone shown in FIG. 2.

Referring to FIGS. 1 to 9, the housing 500 is disposed within the heat sink 400. Specifically, the housing 500 may be disposed in the receiver 470 of the heat sink 400.

The housing 500 has an appearance corresponding to that of the receiver 470 of the heat sink 400. The inside of the housing 500 has a space for receiving the power supply 600.

The housing 500 receives the power supply 600 therein and protects the power supply 600. The housing 500 prevents the heat radiated from the heat sink 400 from being transferred to the power supply 600, thereby preventing the temperature rise of many parts 610 of the power supply 600.

The housing 500 may include an upper housing 510 and a lower housing 550. The upper housing 510 and the lower housing 550 are coupled to each other and may receive the power supply 600 therein.

The upper housing 510 is disposed between the member 410 of the heat sink 400 and the upper portion of the power supply 600. Since the upper housing 510 is disposed behind the light source module 200 which generates the most heat in the heat sink 400, the amount of the temperature rise of the parts 610 of the power supply 600 can be reduced.

The lower housing 550 is disposed between the base 430 of the heat sink 400 and the lower portion of the power supply 600. Here, a silicone molding process may be performed on the inside of the lower housing 550 in order to fix the lower portion of the power supply 600. The lower housing 550 may be coupled to the socket 700 to which an external electric power is applied.

The housing 500 may be formed of a material having excellent electrical insulation and thermal resistance. For example, the housing 500 may be formed of polycarbonate (PC).

<Power Supply 600>

Referring to FIG. 3, the power supply 600 may include a support plate 630 and many parts 610 mounted on the support plate 630. The many parts 610 may include, for example, a DC converter converting AC power supply

supplied by an external power supply into DC power supply, a driving chip controlling the driving of the light source module 200, an electrostatic discharge (ESD) protective device for protecting the light source module 200, and the like. However, there is no limit to this.

Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to affect such feature, structure, or characteristic in connection with other ones of the embodiments.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A lighting device comprising:

a heat sink which comprises a base and a member extending from the base;

a light source module which is disposed on a lateral surface of the member; [and]

a reflector which is disposed on a top surface of the member and [has a disposition recess exposing the light source module],

a light transmission enclosure coupled to the base and covering the member, the light source module and the reflector

wherein the at least two light source modules are provided, and the light source module [comprises] includes a terminal plate which electrically connects

the at least two light source modules,

and wherein the terminal plate is disposed [on] over the [reflector] lateral surface of the member.

2. The lighting device of claim 1, wherein the reflector has a shape corresponding to that of the member and wherein the reflector covers the member.

3. The lighting device of claim 1, wherein the heat sink comprises a receiver which passes through the base and the member, and wherein the reflector comprises a lower portion having the disposition recess, and an upper portion disposed on the receiver.

4. The lighting device of claim 3, [further comprising a cover which is disposed on the reflector and is coupled to the heat sink.] wherein the upper portion of the reflector has a surface convex toward the [cover] light transmission closure.

5. The lighting device of claim 4, wherein a minimum distance from the upper portion of the reflector to the [cover] light transmission enclosure is equal to or greater than 15 mm.

6. The lighting device of claim 1, wherein an angle between the lateral surface of the member and a central axis

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of the lighting device is equal to or greater than 0.3 degree and equal to or less than 3 degree.

7. The lighting device of claim 1, wherein the lateral surface of the member is curved and wherein the light source module comprises a flexible substrate disposed on the curved surface and a light emitting diode disposed on the substrate.

8. A lighting device comprising:

a heat sink comprising a base including a heat radiating fin, and a member which extends from the base and has at least one lateral surface; [and]

a light source module disposed on the lateral surface of the member of the heat sink and comprising a light emitting device[.];

a reflector which is disposed on a top surface of the member; and

a light transmission enclosure coupled to base, and covering the member, the light source and the reflector;

wherein the heat radiating fin comprises an upper portion and a lower portion, wherein a width of the upper portion of the heat radiating fin increases with the approach to a lower portion of the base from an upper portion of the base, wherein a width of the lower portion of the heat radiating fin decreases with the approach to the lower portion of the base from the upper portion of the base,

and wherein the upper portion of the heat radiating fin is disposed under a light distribution area of light emitted from the light source module and is not overlapped with the light distribution area.

9. The lighting device of claim 8, wherein a thickness of the heat radiating fin is equal to or larger than 0.8 mm and is equal to or less than 3.0 mm.

10. The lighting device of claim 8, wherein on the basis of a vertical axis passing through a center of the light emitting device, a maximum emission angle of the light emitting device is defined by an angle between the vertical axis and a tangent line passing through both the center of the light emitting device and a contact point of the upper portion of the heat radiating fin.

11. The lighting device of claim 8, wherein a plurality of the heat radiating fins are disposed to surround the outer surface of the base of the heat sink and are separated from each other at a predetermined interval, and wherein an interval between the outermost ends of the two adjacent heat radiating fins among the plurality of the heat radiating fins is different from an interval between the innermost ends of the two adjacent heat radiating fins.

12. The lighting device of claim 8, wherein the light source module comprises a substrate disposed on the lateral surface of the member of the heat sink, and the light emitting device disposed on the substrate, wherein an area of the lateral surface of the member is greater than that of the bottom surface of the substrate, and wherein the substrate is disposed to lean more on the lower portion of the lateral surface of the member than the upper portion of the lateral surface of the member, so that a portion of the lateral surface of the member is exposed.

13. The lighting device of claim 12, wherein a distance from the uppermost portion of the member to the uppermost portion of the substrate is equal to or greater than 3 mm and is equal to or less than 5 mm.

14. The lighting device of claim 12, wherein the heat sink comprises a receiver passing through the base and the member and wherein the member further comprises an extension part extending toward the receiver.

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15. The lighting device of claim 14, wherein a length of the extension part is equal to or greater than 10 mm and is equal to or less than 20 mm on the basis of the lateral surface of the member.

16. The lighting device of claim 12, wherein a thickness of the member is equal to or larger than 2.5 mm and is equal to or less than 5 mm.

17. A lighting device comprising:

a heat sink comprising a base and a member disposed on the base;

a light source module disposed on a lateral surface of the member of the heat sink;

a light transmission enclosure coupled to base, and covering the member and the light source module;

a housing which is disposed in the base of the heat sink [and inside the member of the heat sink] and is formed of a material having electrical insulation; and

a power supply which is received inside the housing and the member, and supplies electrical power to the light source module,

wherein the housing comprises [an upper housing and] a lower housing, [wherein the upper housing is surrounded by the member of the heat sink.] wherein the lower housing is surrounded by the base of the heat sink,

[wherein the upper housing receives an upper portion of the power supply.] and wherein the lower housing receives [the rest] a lower portion of the power supply.

18. The lighting device of claim 17, wherein the heat sink comprises a receiver which passes through the base and the member, wherein the receiver of the heat sink is a through-hole, and wherein the through-hole has a shape corresponding to that of the housing.

19. The lighting device of claim 18, wherein the through-hole comprises an upper portion defined by the member of the heat sink, and a lower portion defined by the base of the heat sink, and wherein a space volume of the upper portion of the through-hole is different from that of the lower portion of the through-hole.

20. The lighting device of claim 17, wherein the lower housing comprises a molding part for fixing the power supply.

21. A lamp, comprising:

an optically transmissive enclosure defining a hollow interior;

a heat sink including an extension having a plurality of walls extending in a first direction into the hollow interior, the plurality of walls forming a through hole extending from a lower end of the extension to an upper end of the extension;

a plurality of first light emitting devices provided over a first wall of the plurality of walls;

a connector configured to receive electric power from an external power source;

a power circuitry extending in the first direction, wherein the power circuitry extends into the through hole from the lower end of the extension;

a base in which the power circuitry is provided; wherein the optically transmissive enclosure transmits a light from the plurality of the first light emitting devices.

22. The lamp of claim 21 further comprises a cover to cover the upper end of the extension.

23. The lamp of claim 22, wherein the cover is a reflector.

24. The lamp of claim 23, wherein the reflector includes at least one sidewall extending over at least one wall of the extension.

25. The lamp of claim 21, wherein the power circuitry includes a plate, the plate extending into the through hole.

26. The lamp of claim 25, wherein the plate includes at least one lead, the at least one lead extending into the through hole.

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27. The lamp of claim 21, wherein the plurality of first light emitting devices is provided on a first substrate, the first substrate provided on the first wall such that the first light emitting devices faces the hollow interior.

28. The lamp of claim 27, further comprising a plurality of second light emitting devices provided over a second wall of the plurality of walls.

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29. The lamp of claim 28, wherein the plurality of second light emitting devices is provided on a second substrate, the second substrate provided on the second wall such that the second light emitting devices faces the hollow interior.

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30. The lamp of claim 29, wherein the first and second substrates are coupled to each other.

31. The lamp of claim 21, wherein the heat sink further includes a heat sink body beneath the lower end of the extension, the heat sink body having a plurality of heat radiating fins provided on an outer circumference of the heat sink body, wherein the through hole extends through the heat sink body.

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32. The lamp of claim 21, wherein the connector is a cap configured to be screwed into a socket.

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33. The lamp of claim 21, wherein the plurality of walls faces a second direction, which is perpendicular to the first direction.

34. The lamp of claim 21, wherein the optically transmissive enclosure is a bulb shaped enclosure.

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